GENESIS SOLAR WIND SAMPLE CURATION: A PROGRESS REPORT.

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Introduction: In the year since the Genesis solar wind collector fragments were returned, early science samples, specimens for cleaning experiments, and science allocations have been distributed. Solar wind samples are stored under nitrogen and handled in an ISO Class 4 (Class 10) laboratory. For array collector fragments, a basic characterization process has been established. This characterization consists of identification of solar wind regime, whole fragment image for identification and surface quality, higher magnification images for contaminant particle density, and assessment of molecular film contaminant thickness via ellipsometry modeling. Compilations of this characterization data for AuOS (gold film on sapphire), and sapphire from the bulk solar wind for fragments > 2 cm are available. Removal of contaminant particles using flowing ultrapure water (UPW) energized megasonically is provided as requested.

Storage and handling of samples: Solar wind samples are stored under nitrogen purge in stainless steel cabinets, but characterized in ISO Class 4 filtered air. The specimens arrived from Utah packaged in glass, polystyrene and polypropylene primary containers. As specimens are cleaned, they migrate to polypropylene containers, unless organic-free storage is required (stainless steel or glass primary containers stored in a separate cabinet).

Early Science allocations: Investigators were provided specimens of gold foil, polished aluminum, bulk metallic glass and concentrator focusing calibration material from which preliminary work was reported in 2005 [1] [2] [3] [4].

Concentrator target de-mounting: Four concentrator targets were removed from their spacecraft mounting and stored under nitrogen.

Basic array fragment characterization: More than 10,000 array collector fragments were returned from Utah [5]. Basic characterization of >250 fragments has been completed and catalogs of available fragments > 2 cm, in longest dimension, of gold-on-sapphire (AuOS) and sapphire have been compiled for investigator use. Basic characterization is comprised of:

Solar wind regime identification. The thickness of the collector fragment identifies the solar wind regime collected [5]. A Mitutoyo Litematic 318-211A direct contact indicator was used to distinguish among 550, 600, 650 and 700-µm thick collector fragments.

Whole fragment surface condition imaging. Fig. 1 shows surface condition, both gouges and particulate debris, highlighted by optimum lighting. These images also serve to calculate usable area and identify the fragment.

Particle density imaging. Microscopic images (both bright field and dark field, Olympus BX51M) with a field of view of 2 mm are useful for determing debris particle densities before and after cleaning or among candidate specimens (Fig. 1).

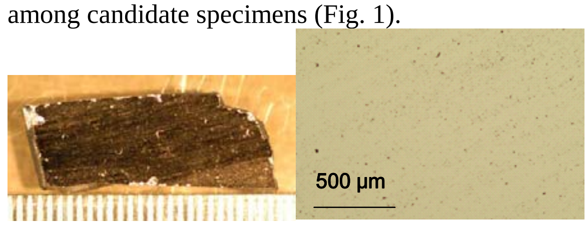

Fig. 1a. Si sample 60171, width = 12 mm.

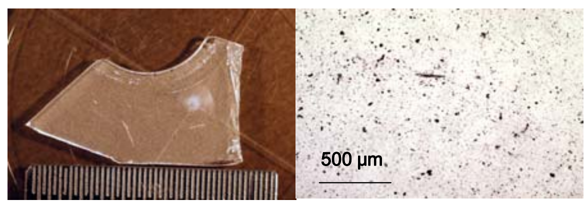

Fig. 1b. Sapphire sample 30458, width = 2 cm.

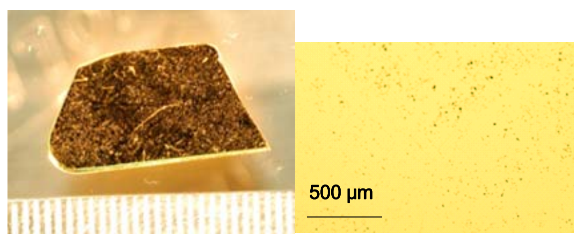

Fig. 1c. AuOS, width = 1 cm.

Molecular film thickness via ellipsometry. Ability to use the WVASE32 to collect ellipsometry data on small Genesis collector fragments and assess thickness of the molecular film contaminant was reported last year by [6] [7]. Separate models are needed for different collector materials and further model development is reported by [8]. Fig. 2 shows molecular film thickness statistics for 112 bulk solar wind collector array samples. The film is an organic layer consisting of Si, C, O and minor F [3] thought to be a result of UV polymerization of off-gas condensate on the collectors. The ellipsometry results show an average film thickness < 50 Å, with 95% less than 100 Å. Thus, the film has not interfered with solar wind collection. Variabil-

ity of average film thickness occurs among material types for bulk array fragments (Table 1). If a condensate mechanism is involved, factors affecting film thickness may include material temperature and proximity to off-gas source; however, the mechanism is complicated by effects of polymerization due to solar exposure. The bulk solar wind collectors were exposed to the sun continually, while other regime collectors were shaded part of the time. Solar exposure temperatures (dependent upon optical properties of the material) were measured during thermal vacuum testing: Si (float zone) 141º C, Si (Czochralski) 156º C, sapphire 56º C, AlOS (aluminum on sapphire) 130º C, AuOS 140º C, Ge 162º C [9]. No correlation of optical property temperature and film thickness is observed with these limited statistics, but additional data from other regimes may be informative.

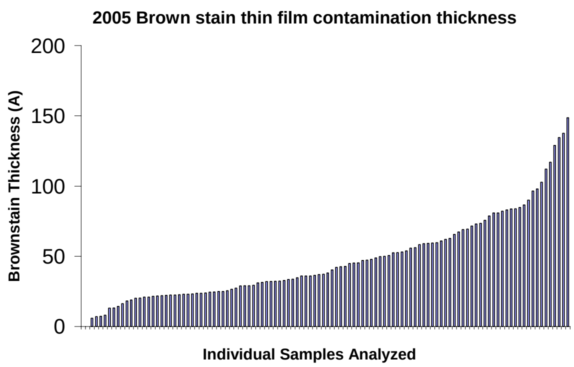

Fig. 2. Distribution of brown stain thickness for 112 bulk solar wind collector fragments of Si, AuOS, AlOS and sapphire materials. Average brown stain thickness is 50 Å.

Table 1. Mean film thickness by substrate material.

Material	Mean film thickness, Å	Count
AlOS	29.1	14
AuOS	42.6	45
SAP	49.2	21
Si	60.8	32

Advanced characterization. The laboratory has been upgraded with an air-bearing table and autofocus microscope (Leica DM 6000M) to make particle mapping of fragments more efficient (Fig. 3). We anticipate in 2006 using FTIR spectra to distinguish FZ Si from CZ Si based on Si-O bonds detectable in CZ Si (Nicolet 6700 FT-IR Optical Spectrometer with Continuum IR Microscope).

Fragment cleaning: Much of the fragment cleaning methodology was developed by the Science Team. Particulate removal requires aqueous methods, while removal of the molecular film requires oxygen plasma or UV ozone.

Ultrapure water. The curatorial staff applied megasonic cleaning with ultrapure water (UPW), used effectively for cleaning some collectors prior to flight, to the removal of particulate debris adhering to collector fragments (Fig.4), details in [10]. This simple process removes most larger particles. Samples will cleaned with UPW if requested.

Cleaning development. One goal for 2006 is standardization of recommended cleaning processes so that Investigators can perform cleaning in their laboratories. Inexpensive, but effective oxygen plasma or UV ozone devices for removal of brown stain molecular film is desirable.

Fig. 3. Air-bearing table, direct thickness measure, bright field/dark field microscope, ellipsometer in ISO Class 4 lab.

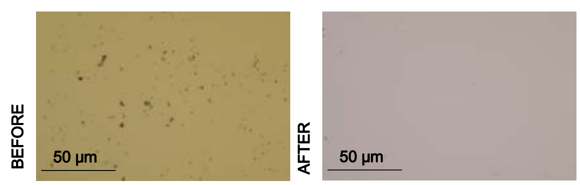

Fig. 4. Si sample 60178 before and after cleaning with megasonic energized flowing UPW. FOV is 200 µm.

References: [1] Schlutter D. J. & Pepin R. O. (2005) AGU Fall Mtg. Abstract # SH32-07, [2] Hohenberg C. M. *et al.* (2005) AGU Fall Mtg. Abstract # SH32-05,[3] Grimberg A. *et al*. (2005) AGU Fall Mtg. Abstract # SH32-06, [4] Heber V. *et al*. (2005) AGU Fall Mtg. Abstract # SH32-08, [5] Allton J. H. *et al*. (2005) LPS XXXVI, Abstract #2083, [6] Stansbery E. K. & McNamara K. M. (2005) LPS XXXVI, Abstract #2145, [7] McNamara K. M. & Stansbery E. K. (2005) LPS XXXVI, Abstract #2402, [8] Calaway M. *et a*l. (2006) LPS XXXVII, Abstract # 1420, [9] Jurewicz A. J. G. *et al*. (2002) *Spa. Sci. Rev.*, **105**, 535-560 (2002), [10] Allton J. H. *et al.* (2006) LPS XXXVII.